

UNITED STATES DEPARTMENT OF AGRICULTURE
AGRICULTURAL RESEARCH SERVICE
MIDWEST AREA

and

Wisconsin Agricultural Experiment Station and other State Experiment Stations, Cooperating

WESTERN REGIONAL SPRING BARLEY NURSERY - 2003 Crop
Preliminary Quality Report

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Detailed Data:

Aberdeen, ID
Idaho Falls, ID
Fairfield, MT
Pullman, WA

Appendix:

Methods
Criteria for Quality Score

This is a joint progress report of cooperative investigations being conducted in the Agricultural Research Service of the U.S. Department of Agriculture and State Agricultural Experiment Stations. It contains preliminary data that have not been sufficiently confirmed to justify general release; interpretations may be modified with additional experimentation. Confirmed results will be published through established channels. The report is primarily a tool available to cooperators and their official staffs and for those persons who have a direct and special interest in the development of improved barleys.

This report includes data furnished by the Agricultural Research Service as well as by the State Agricultural Experiment Stations. The report is not intended for publication and should not be referred to in literature citations nor quoted in publicity or advertising. Use of the data may be granted for certain purposes upon written request to the agency or agencies involved.

Samples malted and analyzed by the Cereal Crops Research Unit, Madison, WI

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Western Regional Spring Barley Nursery – 2003 Crop

Nursery samples were received for malting quality evaluation from four experimental stations located in Idaho, Montana and Washington. The parentages of the nursery entries are listed in Table 1. Seven of 23 entries were new in this year's nursery.

These samples were germinated for 5 days, with rotation for 3 minutes every half hour. These conditions have yielded malts with modification levels similar to those produced by industry. The malting protocol and analytical methods employed are listed in Appendix A. The criteria and value assignments used to calculate quality scores are listed in Appendix B.

The mean values for 14 quality factors are listed over the four stations located in the Western Region (Table 2) and over all varieties (Table 3). Individual station data are reported in Tables 4 through 7. Evaluations of data from individual locations and overall performance evaluations, derived primarily from Tables 2 and 3, are presented below.

The barleys submitted from Aberdeen, ID (Table 4) were very plump and had good low total protein levels. The extract values were exceptional averaging 81.0%, with good fine – coarse differences. Over half of the soluble protein values were too low and several of the new submissions had excessive turbidity. Nearly all of the diastatic power levels were too low, while FAN levels were adequate and α -amylase levels were good. About half of the β -glucan levels were unacceptably high, while that of 2B97-4004 was very low. The best performers were Morex, 2B98-5312, 6B98-9339 and MT960099.

A quarter of the barleys submitted from Idaho Falls, ID (Table 5) were thin, and two thirds of them had unacceptably high protein contents. Over half of the extract values were too low, including most of the new submissions. Most of the clear worts had excellent low turbidities, whereas those of slightly hazy or hazy clarity had high turbidities, as would be expected. Half of the soluble protein and diastatic power levels were too low, as were most of the S/T values. Alpha-amylase and FAN levels were generally good. The majority of these submissions did not modify well, with 19 of 23 β -glucan levels being unacceptably high. The best performers were Stander, 6B98-9940, 2B97-4004 and 6B98-9339.

The submissions from Fairfield, MT (Table 6) were plump and had good protein contents. The extract values were generally good, but two thirds of the soluble protein and diastatic power values were too low. Two thirds of the turbidities and β -glucan levels were too

high, while the α -amylase and FAN values were generally good. The best performers were 2B97-4004, 2B97-4299 and 2B98-5312. Of the first year submissions, only MT960099 showed promise at this location.

Half of the barleys from Pullman, WA (Table 7) were too thin; however their protein contents were quite good. Extract values were generally good, but most of the diastatic power and soluble protein levels were unacceptably low. The α -amylase levels were good, while β -glucan levels ranged from very low to the just above the desired limit. Free amino nitrogen levels were too low in at least a third of the worts. The best performers were 6B98-9339, Stander and 98AB-12905.

In general, the submissions from Aberdeen and Fairfield were very plump and had excellent kernel weights (Table 2), while those from Pullman were a bit thin and kernel weights averaged much lower. Barley protein levels were very good, except for those in barleys from Idaho Falls. The malts generated from barley grown at Aberdeen had excellent extract values, while those from Fairfield and Pullman were quite good and the values from Idaho Falls were lower averaging only 77.1%. Wort color levels were generally good, except in worts from Fairfield, which may have been negatively influenced by the elevated turbidity levels. Soluble protein levels were generally low in worts from all locations and only the averaged S/T value from Aberdeen was acceptable. The averaged diastatic power levels were mostly low, influenced by the low total protein levels found at three of the four locations. The α -amylase and FAN values were generally good at all locations, while β -glucan levels were a bit low in worts from Pullman submissions, slightly elevated in those from Aberdeen and unacceptably high in worts of the Idaho Falls and Fairfield submissions.

A number of these lines showed promise for commercial use. 6B98-9339 scored well at all four locations. This line was plump, even at Pullman, where half of the submissions fell below the desirable limits. 6B98-9339 had extract values that were similar to the experimental controls and its total protein values were highest at three locations (having generally low protein values), but fell between Stander and Morex at Pullman, where the protein levels were generally a bit high. The diastatic power values for this line were too low in extracts of malts from Aberdeen and Pullman, and lower than would be expected in wort from Fairfield and Idaho Falls, where the total protein levels were elevated. The α -amylase values were good, but the β -

glucan levels tended to be a bit high when malted under our standard conditions.

Another promising line was 2B97-4004. This line had excellent extract values that were higher at each location than that of the Harrington experimental controls. Total protein levels were consistently lower than those of Harrington and this line apparently modified readily having the lowest β -glucan levels at each of the locations. 2B97-4004 had excellent soluble protein, α -amylase and turbidity values.

6B98-9940 performed well having protein levels similar to or lower than the experimental controls. The line had good extract, turbidity and α -amylase values and a sufficient amount of free amino nitrogen was present. The β -glucan levels were a bit high in worts derived from three of four locations.

Other lines showed promise at a couple of the locations. 2B98-5312, 95SR 316A and MT960099 performed well at Aberdeen and Fairfield, but were thin at the other locations along with additional malting quality deficiencies.

Entries in the Western Regional Spring Barley Nursery - 2003 Crop

Table 1

Entry No.	New Entry	Cultivar or Selection	Rowed	Parentage	Source
1		MOREX	6	Cree/Bonanza	St. Paul, MN
2		STANDER	6	Robust 2*/3/Cree/Bonanza//Manker/4/Robust/Bumper	St. Paul, MN
3		HARRINGTON	2	Klages/3/Gazelle/Betzes//Centenial	Saskatoon, SK
4		2B97-4004	2	2B91-4947/TR129	BARI (1)
5		2B97-4299	2	2B91-4947/2B91-4450	BARI (1)
6		2B98-5312	2	B1215/TR226/Baronesse	BARI (1)
7		6B98-9339	6	B1614/B1614/M75	BARI (1)
8		6B98-9940	6	6B92-7166/Stander	BARI (1)
9		94AB13449	6	Russel/M64	Aberdeen, ID
10		98AB12362	6	90Ab852/Excel	Aberdeen, ID
11		98AB12905	6	88Y315/82Ab519	Aberdeen, ID
12		95SR316A	2	Bancroft/Crystal	Aberdeen, ID
13		97ID1269A	6	Stander*4/PI366450	Aberdeen, ID
14		98ID242	2	Baronesse/3/Crystal/Klages*3/PI366450	Aberdeen, ID
15	X	MT960099	2	Manley/Baronesse	Bozeman, MT
16	X	MT970229	2	Stark/Baronesse	Bozeman, MT
17	X	SAMISH 23	2	85AB2323/Acclaim	Bellingham, WA
18	X	BOB (WA8682-96)	2	A308/Baronesse	Pullman, WA
19	X	WA10497-97	2	WA9035-84/Baronesse	Pullman, WA
20	X	WA7194-98	2	WA11556-91/Chinook	Pullman, WA
21	X	WA8601-97	2	WA7758-89/Baronesse	Pullman, WA
22		98-NZ015	2	Caminant{ant28-484(Grit)/Blenheim}/Baronesse	Pullman, WA
23		98-NZ223	2	Mut. Pant-667 in Harrington/Baronesse	Pullman, WA

(1) Busch Agricultural Resources, Inc. - Ft Collins, CO

WESTERN REGIONAL SPRING BARLEY NURSERY - 2003 Crop

Table 2 - Station Means* of Barley and Malt Quality Factors for 23 Varieties or Selections**

LOCATION	Kernel Weight (mg)		on 6/64" (%)		Barley Color (Agtron)		Malt Extract (%)		F - C (%)		Wort Color		Turbidity (HACH)		Barley Protein (%)		Wort Protein (%)		S/T (%)		DP (°ASBC)		Alpha-amylase (20°DU)		Beta-glucan (ppm)		FAN (ppm)		Quality Score
ABERDEEN ID	42.2	A	97.9	A	77.7	B	81.0	A	0.9	A	2.3	AB	18.7	AB	10.6	A	4.44	AB	44.5	A	81.0	B	58.3	AB	168	B	216	A	38.3
IDAHO FALLS, ID	38.0	B	80.4	B	73.2	C	77.1	C	1.9	C	2.0	A	15.7	A	14.1	C	4.66	A	34.6	C	110.0	A	52.2	B	380	C	215	A	25.7
FAIRFIELD, MT	42.2	A	94.0	A	71.3	C	79.7	B	1.2	B	2.7	B	26.4	B	11.4	B	4.24	BC	39.0	B	90.0	B	51.9	B	369	C	178	B	36.0
PULLMAN, WA	33.2	C	73.6	C	84.9	A	79.5	B	0.7	A	2.1	A	12.3	A	10.6	A	4.06	C	39.7	B	81.0	B	60.1	A	63	A	180	B	28.7

* Within each column, means followed by the same letter are not significantly different (alpha=0.05), according to Duncan's Multiple Range Test

** Morex, Stander, Harrington, 2B97-4004, 2B97-4299, 2B98-5312, 6B98-9339, 6B98-9940, 94AB13449, 98AB12362, 98AB12905, 95SR316A, 97ID1269A, 98ID242, MT960099, MT970229, SAMISH 23, BOB, WA10497-97, WA7194-98, WA8601-97, 98NZ015, 98NZ223

WESTERN REGIONAL SPRING BARLEY NURSERY - 2003 Crop

Table3 - Varietal Means* of Barley and Malt Quality Factors for all Stations**

		Kernel Weight		on 6/64"		Barley Color (Agtron)		Malt Extract (%)		F - C		Wort Color		Turbidity		Barley Protein (%)		Wort Protein (%)		S/T (%)		DP (°ASBC)		Alpha-amylase (20°DU)		Beta-glucan (ppm)		FAN		Quality Score	
Variety or Selection	Rowed	(mg)		(%)												(%)		(%)			(%)										
MOREX	6	34.6	C	80.9	A	82.5	A	78.3	BCD	1.0	AB	2.0	ABC	18.7	AB	12.6	A	4.5	BCD	37.6	BCDE	143.8	A	52.3	GHI	258	AB	197	CDEF	34.5	
STANDER	6	36.0	BC	91.6	A	80.5	AB	79.8	ABCD	0.7	A	2.4	ABCD	19.7	AB	11.8	A	5.0	AB	44.6	AB	105.1	BCDE	63.0	BCDEF	246	AB	232	ABCD	42.3	
HARRINGTON	2	39.7	ABC	88.4	A	75.5	ABC	79.8	ABCD	1.4	AB	1.5	A	5.4	A	12.8	A	4.7	BC	38.1	BCDE	102.6	BCDEF	60.3	CDEFG	313	AB	207	BCDE	34.3	
2B97-4004	2	39.1	ABC	87.2	A	79.3	AB	82.1	A	0.6	A	2.0	ABCD	6.2	A	11.0	A	4.8	BC	46.1	A	97.7	BCDEF	66.2	ABCD	45	A	241	ABC	42.5	
2B97-4299	2	39.4	ABC	86.3	A	77.3	AB	79.9	ABCD	0.8	AB	2.0	ABC	7.7	A	11.8	A	4.6	BC	42.2	ABC	109.8	BCD	69.5	ABC	195	AB	214	BCDE	34.3	
2B98-5312	2	38.1	ABC	69.3	A	71.8	ABC	79.5	ABCD	1.1	AB	2.0	ABC	6.6	A	11.9	A	4.7	BC	42.0	ABC	93.9	BCDEF	72.6	A	171	AB	235	ABC	33.5	
6B98-9339	6	36.1	BC	91.5	A	76.3	ABC	79.3	ABCD	1.2	AB	2.2	ABCD	7.5	A	12.9	A	5.4	A	43.9	ABC	115.0	BC	63.9	ABCDE	141	AB	279	A	46.5	
6B98-9940	6	38.4	ABC	89.3	A	77.3	AB	79.7	ABCD	1.0	AB	2.0	ABCD	7.5	A	12.0	A	5.0	AB	43.6	ABC	120.7	AB	53.9	FGHI	188	AB	265	A	42.0	
94AB13449	6	37.4	ABC	92.4	A	69.8	BC	80.8	ABC	1.1	AB	3.7	E	46.3	C	10.1	A	4.2	CDEFG	44.0	ABC	75.2	FG	50.2	HIJ	263	AB	201	BCDEF	35.8	
98AB12362	6	37.3	ABC	91.8	A	83.3	A	79.8	ABCD	1.2	AB	2.8	BCDE	31.7	BC	11.0	A	4.3	CDEFG	41.7	ABC	108.4	BCD	52.3	GHI	314	AB	184	DEFGH	34.5	
98AB12905	6	36.9	BC	93.9	A	69.8	BC	81.3	AB	1.1	AB	3.0	DE	22.4	AB	10.0	A	4.6	BCD	47.5	A	58.4	GH	62.7	BCDEF	419	B	238	ABC	38.5	
95SR316A	2	40.5	ABC	82.4	A	80.5	AB	79.5	ABCD	1.2	AB	1.8	A	8.5	A	12.4	A	4.4	CDE	37.5	BCDE	97.7	BCDEF	63.8	ABCDE	208	AB	192	CDEFG	33.8	
97ID1269A	6	37.4	ABC	90.3	A	79.0	AB	79.2	ABCD	1.2	AB	2.3	ABCD	17.9	AB	11.5	A	4.8	BC	43.2	ABC	112.6	BC	56.5	EFGH	302	AB	249	AB	38.3	
98ID242	2	45.1	A	94.4	A	82.8	A	80.4	ABCD	0.6	A	2.1	ABCD	13.0	AB	11.0	A	4.4	CDEF	41.2	ABCD	89.6	CDEF	60.5	CDEFG	145	AB	213	BCDE	35.5	
MT960099	2	40.0	ABC	83.0	A	73.8	ABC	80.3	ABCD	0.8	AB	2.0	ABC	5.2	A	10.8	A	4.7	BC	45.4	AB	92.5	BCDEF	70.7	AB	121	AB	238	ABC	37.3	
MT970229	2	43.4	AB	86.2	A	78.0	AB	77.8	CD	1.6	AB	2.9	BCDE	28.5	BC	12.1	A	3.8	FGH	32.9	E	80.5	DEFG	45.5	IJ	380	B	141	HI	21.8	
SAMISH 23	2	38.0	ABC	78.5	A	75.3	ABC	77.4	D	2.2	B	1.9	ABC	23.4	AB	12.2	A	3.7	GH	32.1	E	73.1	FG	34.6	K	390	B	141	HI	17.0	
BOB (WA8682-96)	2	40.5	ABC	87.0	A	77.8	AB	79.3	ABCD	1.2	AB	2.3	ABCD	29.0	BC	11.4	A	3.9	EFGH	36.1	CDE	74.1	FG	49.1	HIJ	234	AB	153	FGHI	23.5	
WA10497-97	2	39.4	ABC	91.0	A	78.3	AB	78.0	BCD	1.4	AB	1.8	A	17.4	AB	12.1	A	3.8	EFGH	33.2	E	87.8	CDEF	46.3	IJ	286	AB	143	GHI	24.0	
WA7194-98	2	39.5	ABC	85.2	A	81.0	AB	78.2	BCD	1.9	AB	1.7	A	15.9	AB	12.4	A	3.9	EFGH	32.8	E	76.3	EFG	42.3	JK	445	B	154	FGHI	20.0	
WA8601-97	2	40.9	ABC	88.2	A	73.8	ABC	77.2	D	1.5	AB	2.9	CDE	29.5	BC	12.0	A	3.5	H	31.6	E	54.0	GH	42.4	JK	203	AB	118	I	20.0	
98-NZ015	2	38.7	ABC	86.9	A	64.8	C	77.9	CD	1.5	AB	3.5	E	44.3	C	11.7	A	4.0	DEFGH	36.5	CDE	45.1	H	41.5	JK	231	AB	164	EFGHI	23.0	
98-NZ223	2	38.6	ABC	74.0	A	78.3	AB	79.0	ABCD	1.0	AB	1.8	AB	8.5	A	10.9	A	3.5	H	33.6	DE	73.9	FG	59.4	DEFG	139	AB	135	HI	28.5	

* Within each column, means followed by the same letter are not significantly different (alpha=0.05), according to Duncan's Multiple Range Test

** Aberdeen, ID, Idaho Falls, ID, Fairfield, MT, and Pullman, WA

2003 WESTERN REGIONAL SPRING BARLEY NURSERY - ABERDEEN, ID

Table 4

Lab No.	Variety or Selection	Rowed	Kernel Weight (mg)	on 6/64" (%)	Barley Color (Agtron)	Malt Extract (%)	F - C	Wort Color	Turbidity	Wort Clarity	Barley Protein (%)	Wort Protein (%)	S/T (%)	DP (*ASBC)	Alpha-amylase (20°DU)	Beta-glucan (ppm)	FAN	Quality Score	Overall Rank
5045	MOREX	6	36.7	*92.2	84	79.9	0.5	1.8	15.9	1	11.9	4.78	43.1	*161	58.1	83	231	54	1
5046	STANDER	6	37.9	97.4	84	80.7	0.5	2.2	18.5	1	11.1	4.80	45.5	90	58.0	201	241	42	5
5047	HARRINGTON	2	44.8	99.0	75	81.8	1.0	1.6	5.5	1	11.5	4.69	41.9	89	62.1	216	227	42	5
5048	2B97-4004	2	42.3	98.3	81	84.3	0.9	1.9	6.5	1	9.9	4.50	50.3	88	63.8	24	230	37	13
5049	2B97-4299	2	43.2	98.9	74	82.4	0.6	2.3	13.7	1	10.3	4.28	45.6	78	64.4	295	204	42	5
5050	2B98-5312	2	42.3	94.1	69	81.7	1.2	2.1	11.2	1	10.7	4.57	46.0	69	73.1	139	238	49	2
5051	6B98-9339	6	38.0	95.4	81	80.4	2.0	2.3	8.8	1	12.0	5.39	47.5	89	67.7	130	312	49	2
5052	6B98-9940	6	40.3	98.1	81	80.8	0.9	2.1	7.5	1	11.5	5.00	45.2	106	57.6	211	267	42	5
5053	94AB13449	6	39.3	98.6	78	82.0	0.7	2.3	18.2	1	9.0	4.48	50.2	74	57.7	100	236	41	10
5054	98AB12362	6	39.5	99.3	82	81.2	0.4	n.d.	37.0	3	9.7	4.46	51.4	82	57.4	204	189	32	20
5055	98AB12905	6	39.3	98.9	77	82.7	0.7	2.5	9.7	1	9.3	4.79	55.2	52	68.0	230	279	34	16
5056	95SR316A	2	44.8	99.3	78	81.5	1.2	2.0	11.4	1	10.7	4.46	44.6	86	68.6	173	225	42	5
5057	97ID1269A	6	39.7	97.1	83	80.1	0.9	2.1	11.9	1	10.9	5.19	47.7	106	60.0	213	287	37	13
5058	98ID242	2	48.5	99.7	86	82.0	0.9	2.7	22.0	2	9.7	4.52	47.4	70	62.6	245	225	36	15
5059	MT960099	2	42.0	96.7	72	81.5	1.0	2.2	8.5	1	9.7	4.69	50.6	80	72.8	107	263	43	4
5060	MT970229	2	47.8	99.3	75	78.8	0.4	n.d.	35.0	3	11.3	3.72	34.1	78	47.5	400	162	26	23
5061	SAMISH 23	2	41.7	97.9	75	80.2	1.0	1.7	22.0	2	11.1	3.91	38.0	76	39.4	86	171	33	17
5062	BOB (WA8682-96)	2	45.1	99.1	73	80.9	1.1	2.4	30.0	2	10.6	4.04	40.7	74	49.9	136	158	33	17
5064	WA10497-97	2	43.5	99.5	82	79.9	0.9	1.6	12.4	1	11.3	4.21	39.3	87	52.3	106	173	38	11
5065	WA7194-98	2	43.8	98.5	81	80.7	0.6	1.8	13.0	1	11.0	4.11	39.9	75	47.4	236	167	31	21
5066	WA8601-97	2	45.3	99.3	75	79.6	0.8	n.d.	47.0	3	10.3	3.72	38.4	50	42.7	104	146	33	17
5067	98-NZ015	2	41.4	98.4	66	79.9	0.8	n.d.	52.0	3	10.1	3.86	39.8	42	43.8	150	166	28	22
5068	98-NZ223	2	43.1	97.5	75	81.0	0.9	2.5	11.8	1	10.0	3.93	40.6	61	65.9	82	172	38	11
5031	MOREX MALT CHECK	6	33.9	86.5	76	79.4	0.7	1.7	8.6	1	13.0	5.22	42.4	157	56.8	65	248	61	
5063	MOREX MALT CHECK	6	34.6	84.6	79	79.6	0.3	2.0	10.4	1	12.5	5.24	42.5	148	55.2	106	261	65	
Minima			36.7	94.1	66	78.8	0.4	1.6	5.5		9.0	3.72	34.1	42	39.4	24	146	26	
Maxima			48.5	99.7	86	84.3	2.0	2.7	52.0		12.0	5.39	55.2	106	73.1	400	312	54	
Means			42.2	98.2	78	81.0	0.9	2.1	18.7		10.6	4.44	44.5	77	58.3	168	216	38	
Standard Deviations			3.1	1.4	5	1.2	0.3	0.3	13.0		0.8	0.46	5.2	16	9.6	84	47	7	
Coefficients of Variation			7.3	1.4	7	1.5	39.4	14.4	69.4		7.8	10.27	11.7	21	16.5	50	22	18	

Malt Check Data are Excluded from Rank Sorting and Statistics

Table Data Flagged by an Asterisk Exceed the Mean by +/- 3 Standard Deviations and are Excluded from Statistics

For Wort Clarity - 1 = clear, 2 = slightly hazy, 3 = hazy; Wort Colors were not determined (n.d.) on hazy samples

Samples Submitted by D. Obert, USDA/ARS - Aberdeen

2003 WESTERN REGIONAL SPRING BARLEY NURSERY - IDAHO FALLS, ID

Table 5

Lab No.	Variety or Selection	Rowed	Kernel Weight (mg)	on 6/64" (%)	Barley Color (Agtron)	Malt Extract (%)	F-C	Wort Color	Turbidity	Wort Clarity	Barley Protein (%)	Wort Protein (%)	S/T (%)	DP (°ASBC)	Alpha-amylase (20°DU)	Beta-glucan (ppm)	FAN (ppm)	Quality Score	Overall Rank
5236	Morex	6	35.3	76.7	85	76.2	1.6	2.1	24.0	2	14.9	4.77	32.7	164	47.3	421	182	23	13
5256	Stander	6	36.8	91.3	77	78.9	1.1	2.2	12.0	1	13.2	5.53	45.2	115	65.6	347	252	48	1
5296	Harrington	2	38.0	77.2	75	76.9	2.3	1.3	3.4	1	15.5	5.18	34.2	124	56.9	480	243	25	11
5302	2B97-4004	2	39.5	87.7	73	80.6	0.6	1.8	4.7	1	12.0	4.89	41.8	111	62.2	68	238	45	3
5286	2B97-4299	2	35.8	79.7	80	76.0	1.4	1.6	4.0	1	15.7	5.29	34.6	159	67.6	282	241	23	13
5289	2B98-5312	2	38.1	72.0	62	76.9	1.5	1.9	4.1	1	15.2	5.47	37.7	143	69.5	339	293	25	11
5279	6B98-9339	6	37.0	90.9	72	79.1	1.0	2.4	6.2	1	14.2	5.60	41.4	137	62.9	174	276	43	4
5308	6B98-9940	6	39.3	93.5	72	79.0	1.5	1.8	4.9	1	13.9	5.43	40.7	149	50.7	239	321	48	1
5281	94AB13449	6	38.8	90.8	59	80.6	1.0	n.d.	68.0	3	11.3	4.45	41.9	94	48.7	295	243	32	10
5285	98AB12362	6	37.7	86.2	81	78.4	2.0	n.d.	36.0	3	12.9	4.53	36.1	145	48.9	500	188	41	6
5290	98AB12905	6	36.1	86.9	59	80.0	1.9	2.9	21.0	2	11.4	4.98	44.0	58	54.2	725	256	41	6
5291	95SR316A	2	37.2	66.8	75	75.9	2.4	1.8	9.1	1	16.2	5.06	31.4	126	57.8	393	224	23	13
5305	97ID1269A	6	37.8	93.4	71	78.4	1.2	1.7	5.0	1	13.6	5.21	38.9	133	56.9	338	301	42	5
5300	98ID242	2	45.7	92.8	77	78.4	0.8	1.7	7.0	1	13.8	4.59	34.0	117	55.9	181	228	33	9
5288	MT960099	2	39.8	79.8	74	79.3	0.8	1.8	2.9	1	12.2	4.89	41.4	111	69.6	153	263	35	8
5252	MT970229	2	40.5	79.8	75	75.3	3.2	n.d.	32.0	3	14.0	4.10	30.4	83	41.7	597	149	8	18
5303	Samish23	2	36.0	56.1	75	73.8	4.0	1.7	18.5	2	15.6	3.80	25.1	82	32.1	631	152	1	23
5304	Bob	2	39.4	79.5	75	75.2	2.5	1.9	24.0	2	14.1	4.01	28.8	83	44.6	477	162	7	19
5299	WA10497-97	2	36.7	80.1	76	74.5	2.6	1.3	9.3	1	15.5	4.09	27.7	112	43.7	411	155	10	17
5307	WA7194-98	2	36.3	70.6	80	74.4	3.9	1.3	6.5	1	15.8	4.20	27.3	91	36.9	617	177	6	21
5301	WA8601-97	2	38.3	77.3	69	73.0	2.3	1.8	24.0	2	16.0	3.57	23.3	69	38.9	403	123	7	19
5306	98-N2 015	2	36.4	68.8	60	75.4	2.9	2.7	30.0	2	14.2	3.93	28.0	56	37.9	370	153	5	22
5242	98-NZ223	2	38.4	72.1	81	76.9	1.8	1.4	4.9	1	12.7	3.64	29.6	79	50.9	292	132	21	16
5280	MOREX MALT CHECK	6	35.4	88.0	81	78.5	0.7	2.2	16.7	1	12.4	5.04	41.0	148	56.0	196	258	49	
5309	MOREX MALT CHECK	6	35.2	86.9	80	78.9	0.9	1.9	10.6	1	12.5	4.98	41.8	135	53.0	185	251	46	
Minima			35.3	56.1	59	73.0	0.6	1.3	2.9		11.3	3.57	23.3	56	32.1	68	123	1	
Maxima			45.7	93.5	85	80.6	4.0	2.9	68.0		16.2	5.60	45.2	164	69.6	725	321	48	
Means			38.0	80.4	73	77.1	1.9	1.8	15.7		14.1	4.66	34.6	111	52.2	380	215	26	
Standard Deviations			2.2	9.9	7	2.2	1.0	0.4	15.5		1.5	0.64	6.5	32	11.0	165	58	16	
Coefficients of Variation			5.7	12.3	10	2.9	49.9	23.5	98.4		10.7	13.76	18.7	29	21.0	44	27	60	

Malt Check Data are Excluded from Rank Sorting and Statistics

Table Data Flagged by an Asterisk Exceed the Mean by +/- 3 Standard Deviations and are Excluded from Statistics

For Wort Clarity - 1 = clear, 2 = slightly hazy, 3 = hazy; Wort Colors were not determined (n.d.) on hazy samples

Samples Submitted by B. Cooper and S. Askelson, BARI - Ft. Collins, CO

2003 WESTERN REGIONAL SPRING BARLEY NURSERY - FAIRFIELD, MT

Table 6

Lab No.	Variety or Selection	Rowed	Kernel Weight (mg)	on 6/64" (%)	Barley Color (Agtron)	Malt Extract (%)	F-C	Wort Color	Turbidity	Wort Clarity	Barley Protein (%)	Wort Protein (%)	S/T (%)	DP (°ASBC)	Alpha-amylase (20°DU)	Beta-glucan (ppm)	FAN (ppm)	Quality Score	Overall Rank
5265	Morex	6	35.7	89.2	77	78.1	1.8	2.3	26.0	2	12.7	4.16	34.7	132	40.3	504	159	33	15
5274	Stander	6	37.2	95.3	79	79.9	1.0	n.d.	41.0	3	11.6	4.74	41.9	108	61.2	401	180	37	9
5269	Harrington	2	42.3	92.0	71	79.7	1.2	1.7	7.5	1	13.0	4.63	36.5	111	58.1	497	183	43	5
5245	2B97-4004	2	43.2	93.4	75	81.6	0.3	2.3	7.8	1	11.3	4.99	47.2	103	59.4	80	241	52	1
5247	2B97-4299	2	46.8	97.2	71	81.1	0.8	2.2	7.8	1	10.7	4.55	45.6	100	65.8	183	204	45	2
5243	2B98-5312	2	43.8	95.8	68	81.1	1.0	2.1	5.2	1	10.9	4.51	42.8	80	67.0	181	213	45	2
5253	6B98-9339	6	38.0	95.2	67	78.0	0.7	2.1	6.5	1	13.4	5.26	41.3	122	58.9	234	249	44	4
5278	6B98-9940	6	40.8	95.9	74	79.6	0.9	2.0	11.0	1	11.6	4.61	41.3	128	51.4	259	221	43	5
5241	94AB13449	6	37.4	91.4	57	79.1	1.9	n.d.	64.0	2	10.5	4.02	40.0	73	41.1	598	141	30	18
5272	98AB12362	6	38.9	96.1	79	79.9	1.4	n.d.	47.0	3	10.7	3.99	37.8	111	46.9	526	181	32	17
5277	98AB12905	6	38.8	95.9	62	80.7	1.8	n.d.	52.0	3	9.9	4.21	44.3	57	54.4	652	200	37	9
5264	95SR 316A	2	46.0	97.0	80	80.0	0.6	1.7	7.3	2	11.9	4.26	37.3	105	61.4	183	185	42	7
5267	97ID1269A	6	39.3	94.3	76	79.6	2.2	n.d.	44.0	3	11.1	4.55	42.8	110	51.2	606	198	37	9
5257	98ID242	2	46.1	96.3	82	80.5	0.7	1.9	10.0	2	10.4	4.01	39.5	87	54.7	110	184	37	9
5244	MT960099	2	44.3	94.7	67	80.5	0.9	2.2	4.7	1	10.9	4.80	45.6	91	65.1	185	223	42	7
5255	MT970229	2	47.9	*76.7	76	78.4	1.5	n.d.	42.0	3	12.1	3.85	33.4	83	46.5	428	132	26	21
5260	Samish23	2	42.1	94.4	67	78.1	2.7	2.0	18.0	2	11.5	3.51	31.6	71	31.7	646	117	20	23
5240	Bob	2	44.0	96.3	72	81.9	0.8	3.5	46.0	2	10.5	3.80	38.4	69	47.8	269	143	33	15
5275	WA10497-97	2	43.2	97.1	69	78.8	0.9	2.8	34.0	2	11.2	3.63	33.0	80	45.9	506	124	27	20
5270	WA7194-98	2	43.0	95.0	75	78.9	1.8	n.d.	30.0	3	11.7	3.80	33.1	76	41.3	726	159	28	19
5251	WA8601-97	2	46.5	97.6	69	78.3	1.1	n.d.	42.0	3	11.2	3.48	33.5	54	45.6	250	121	26	21
5250	98-N2015	2	42.6	93.8	59	78.2	2.1	n.d.	47.0	3	11.7	4.70	42.6	44	38.9	350	200	36	13
5273	98-NZ-223	2	43.7	92.5	69	80.0	0.4	1.7	7.5	1	10.8	3.49	33.5	82	58.4	122	127	34	14
5280	MOREX MALT CHECK	6	35.4	88.0	81	78.5	0.7	2.2	16.7	1	12.4	5.04	41.0	148	56.0	196	258	49	
Minima			35.7	89.2	57	78.0	0.3	1.7	4.7		9.9	3.48	31.6	44	31.7	80	117	20	
Maxima			47.9	97.6	82	81.9	2.7	3.5	64.0		13.4	5.26	47.2	132	67.0	726	249	52	
Means			42.2	94.8	71	79.6	1.2	2.2	26.4		11.4	4.24	39.0	90	51.9	369	178	36	
Standard Deviations			3.4	2.1	7	1.2	0.6	0.5	19.1		0.9	0.51	4.7	24	9.7	200	39	8	
Coefficients of Variation			8.1	2.2	9	1.5	50.0	22.2	72.3		7.5	11.99	12.1	26	18.7	54	22	22	

Malt Check Data are Excluded from Rank Sorting and Statistics

Table Data Flagged by an Asterisk Exceed the Mean by +/- 3 Standard Deviations and are Excluded from Statistics

For Wort Clarity - 1 = clear, 2 = slightly hazy, 3 = hazy; Wort Colors were not determined (n.d.) on hazy samples

Samples Submitted by B. Cooper and S. Askelson, BARI - Ft. Collins, CO

2003 WESTERN REGIONAL SPRING BARLEY NURSERY - PULLMAN, WA

Table 7

Lab No.	Variety or Selection	Rowed	Kernel Weight (mg)	on 6/64" (%)	Barley Color (Agtron)	Malt Extract (%)	F-C	Wort Color	Turbidity	Wort Clarity	Barley Protein (%)	Wort Protein (%)	S/T (%)	DP (°ASBC)	Alpha-amylase (20°DU)	Beta-glucan (ppm)	FAN	Quality Score	Overall Rank
5071	MOREX	6	30.5	65.5	84	79.2	0.3	1.7	8.9	1	11.1	4.39	40.0	119	63.4	26	214	28	11
5072	STANDER	6	32.1	82.4	82	79.8	0.3	2.0	7.4	1	11.4	5.04	45.8	109	67.2	36	256	42	2
5073	HARRINGTON	2	33.8	85.5	81	80.8	0.9	1.5	5.1	1	11.2	4.14	39.9	87	64.3	60	174	27	13
5074	2B97-4004	2	31.4	69.4	88	81.8	0.4	2.0	5.9	1	11.0	4.91	45.1	89	79.3	9	256	36	6
5075	2B97-4299	2	31.8	69.5	84	80.3	0.5	1.8	5.4	1	10.3	4.39	42.9	102	80.1	20	205	27	13
5076	2B98-5312	2	28.3	15.4	88	78.3	1.0	1.7	5.9	1	10.7	4.11	41.4	84	80.7	25	197	15	20
5077	6B98-9339	6	31.3	84.4	85	79.7	0.8	2.2	8.3	1	12.0	5.31	45.3	112	66.2	26	278	50	1
5078	6B98-9940	6	33.3	69.6	82	79.4	0.7	2.1	6.4	1	11.1	5.05	47.0	100	55.9	41	251	35	8
5079	94AB13449	6	34.2	88.8	85	81.3	1.0	n.d.	35.0	3	9.5	4.01	43.7	60	53.2	58	184	40	4
5080	98AB12362	6	33.2	85.4	91	79.8	0.9	1.9	6.9	2	10.6	4.02	41.6	95	56.0	26	178	33	9
5081	98AB12905	6	33.6	93.7	81	81.7	0.2	2.0	6.9	1	9.5	4.32	46.4	66	74.2	70	217	42	2
5082	95SR316A	2	34.1	66.6	89	80.5	0.5	1.6	6.1	1	10.8	3.76	36.9	73	67.5	81	136	28	11
5083	97ID1269A	6	32.8	76.4	86	78.8	0.7	1.7	10.6	1	10.5	4.37	43.4	101	58.0	49	212	37	5
5084	98ID242	2	40.3	88.8	86	80.9	0.1	2.3	13.0	1	10.0	4.37	43.8	84	68.6	44	215	36	6
5085	MT960099	2	33.8	60.8	82	79.9	0.6	1.8	4.5	1	10.1	4.25	43.9	88	75.2	42	202	29	10
5086	MT970229	2	37.5	89.1	86	78.8	1.3	3.2	5.1	1	10.9	3.49	33.6	78	46.3	95	119	27	13
5087	SAMISH 23	2	32.3	65.7	84	77.3	1.0	2.2	35.0	2	10.8	3.56	33.9	64	35.1	200	126	14	22
5088	BOB (WA8682-96)	2	33.5	73.0	91	79.3	0.5	1.7	16.0	1	10.3	3.60	36.3	69	54.1	55	146	21	17
5089	WA10497-97	2	34.2	87.3	86	78.9	1.2	1.4	14.0	1	10.2	3.33	33.1	72	43.4	120	122	21	17
5090	WA7194-98	2	34.8	76.8	88	78.7	1.3	1.4	14.0	1	11.0	3.31	30.8	63	43.6	203	114	15	20
5091	WA8601-97	2	33.6	78.5	82	77.8	1.7	3.6	4.9	1	10.6	3.10	31.1	42	42.5	54	82	14	22
5092	98-NZ015	2	34.5	86.6	74	78.1	0.1	4.0	48	2	10.6	3.59	35.7	38	45.2	54	137	23	16
5093	98-NZ223	2	29.2	34.0	88	78.0	0.7	1.8	9.9	1	10.0	3.06	30.8	74	62.5	60	110	21	17
5094	MOREX MALT CHECK	6	35.4	87.0	76	79.1	0.7	2.1	19.6	1	13.0	5.00	41.3	157	55.8	81	215	56	
Minima			28.3	15.4	74	77.3	0.1	1.4	4.5		9.5	3.06	30.8	38	35.1	9	82	14	
Maxima			40.3	93.7	91	81.8	1.7	4.0	48.0		12.0	5.31	47.0	119	80.7	203	278	50	
Means			33.2	73.6	85	79.5	0.7	2.1	12.3		10.6	4.06	39.7	81	60.1	63	180	29	
Standard Deviations			2.5	18.2	4	1.2	0.4	0.7	11.4		0.6	0.63	5.5	21	13.3	50	55	10	
Coefficients of Variation			7.5	24.8	4	1.6	56.7	33.1	92.7		5.5	15.61	13.8	26	22.1	80	31	35	

Malt Check Data are Excluded from Rank Sorting and Statistics

Table Data Flagged by an Asterisk Exceed the Mean by +/- 3 Standard Deviations and are Excluded from Statistics

For Wort Clarity - 1 = clear, 2 = slightly hazy, 3 = hazy; Wort Colors were not determined (n.d.) on hazy samples

Samples Submitted by S. Ullrich, Washington State University - Pullman

Appendix A:

METHODS

Cleaning All samples were cleaned on a Carter Dockage Tester and any material not retained on a 5/64" screen was discarded.

Barley Mill Ground barley was prepared with a Labconco Burr mill that was adjusted so that only 35% of the grist remained on a 525 μ m sieve after 3 min of shaking and tapping.

Kernel Weight The number of kernels in a 20 g aliquot of each sample was counted electronically and the '1000 kernel weight' was calculated.

Plumpness Samples were sized on a Eureka-Niagra Barley Grader and the percentage of the seeds retained on a 6/64" screen was determined.

Barley Color The brightness of the grains was measured using an Agtron M45-D analyzer.

Barley Moisture Content Five g of ground sample was dried for 3 h at 106°C. The percentage of weight loss that occurred during this drying was calculated.

Barley Protein Content Total nitrogen values were obtained using an automated Dumas combustion procedure with a LECO FP-528 analyzer. Nitrogen values were converted to protein percentages by multiplication by 6.25.

Malting Conditions 170 g (db) barley samples were steeped at 16°C for 32-48 h, to 45% moisture, by alternating 4 h of wet steep with 4 h of air rest. The steeped samples were placed in a chamber for 5 d at 17°C and near 100% R.H., in cans that were rotated for 3.0 min every 30 min. The germinated grain (green malt) was kilned for 24 h as follows: 0.5 h from 25°C to 49°C, 9.5 h at 49°C, 0.5 h from 49°C to 54°C, 4.0 h at 54°C, 0.5 h from 54°C to 60°C, 3.0 h at 60°C, 0.5 h from 60°C to 68°C, 2.0 h at 68°C, 0.5h from 68°C to 85°C, and 3.0 h at 85°C.

Malt Mill Fine-grind malts were prepared with a Miag laboratory cone mill that was adjusted so that 10% of the grist remained on a 525 μ m sieve after 3 min of shaking, with tapping. Coarse-grind malts were prepared with a corrugated roll mill that was adjusted so that 75% of the grist remained on a 525 μ m sieve. Ground malts for moisture, protein and amyolytic activity analyses were ground in a Labconco Burr mill (see Barley Mill).

Malt Moisture Content See Barley Moisture Content.

Malt Protein Content See Barley Protein Content.

Malt Extract Samples were extracted using the Malt-4 procedure (Methods of Analysis of the ASBC, 8th ed, 1992), except that all weights and volumes specified for the method were halved. The specific gravity of the filtrate was measured with an Anton/Parr DMA5000 density meter. The density data were used to calculate the amount of soluble material present in the filtrate, and thus the percentage that was extracted from the malt. **F-C** represents the difference in extract % between the finely ground malts and the coarsely ground malts.

Wort Color was determined on a Skalar SAN plus analyzer by subtracting the absorbance at 700 nm from that at 430nm and dividing by a factor that was determined by comparison with values obtained in a collaborative test.

Wort Clarity was assessed by visual inspection.

β -Glucan Levels were determined on a Skalar SAN plus analyzer by using the Wort-18 fluorescence flow injection analysis method with calcofluor as the fluorescent agent (Methods of Analysis of the ASBC, 8th ed, 1992).

Free Amino Nitrogen Levels were determined on a Skalar SAN plus analyzer using an automated version of the Wort-12 protocol (Methods of Analysis of the ASBC, 8th ed, 1992).

Soluble (Wort) Protein Levels were determined on a Skalar SAN plus analyzer using the Wort-17 UV-spectrophotometric method (Methods of Analysis of the ASBC, 8th ed, 1992).

S/T Ratio was calculated as Soluble Protein / Total Malt Protein

Diastatic Power Values were determined on a Skalar SAN plus analyzer by the automated ferricyanide procedure Malt-6A (Methods of Analysis of the ASBC, 8th ed, 1992).

α -Amylase activities were measured on a Skalar SAN plus analyzer by heating the extract to 73°C to inactivate any β -amylase present. The remaining (α -amylase) activity was measured as described for Diastatic Power Values.

Turbidities were determined in Nephelometric Turbidity Units (NTU) on a Hach Model 18900 Ratio Turbidimeter.

Quality Scores were calculated by using a modification of the method of Clancy and Ullrich (Cereal Chem. 65:428-430, 1988). The criteria used to quantify individual quality factors are listed in Table A1.

Overall Rank Values were ordered from low to high based on their Quality Scores. A rank of '1' was assigned to the sample with the best quality score.

Appendix B

2003 Crop Year

Quality Score Parameters for 2- and 6-rowed barleys

Quality parameter	2-rowed		6-rowed	
	condition	score	condition	score
Kernel Weight (mg)	> 42.0	5	> 32.0	5
	40.1–42.0	4	30.1–32.0	4
	38.1–40.0	2	28.1–30.0	2
	≤ 38.0	0	≤ 28.0	0
on 6/64 " (%)	≥ 90.0	5	≥ 80.0	5
	85.0–89.9	3	73.0–79.9	3
	< 85.0	0	< 73.0	0
Malt Extract (% db)	≥ 81.0	10	≥ 79.0	10
	79.4–81.0	7	78.2–78.9	7
	78.0–79.4	4	77.7–78.2	4
	< 78.0	0	< 77.7	0
Wort Clarity	= 3	0	= 3	0
	3=hazy	= 2	= 2	1
	2=slightly hazy	= 1	= 1	2
	1=clear			
Barley Protein (% db)	≥ 13.5	0	≥ 14.0	0
	13.0–13.5	5	13.5–13.9	5
	11.5–13.0	10	11.5–13.5	10
	≤ 11.5	5	≤ 11.5	5
Wort Protein (% db)	> 6.0	0	> 6.0	0
	5.6–6.0	3	5.7–6.0	3
	4.9–5.6	7	5.2–5.7	7
	4.5–4.9	3	4.8–5.2	3
	< 4.5	0	< 4.8	0
S/T (Soluble/Total Protein, % db)	> 47	0	> 47	0
	42–47	5	42–47	5
	< 42	0	< 42	0
DP (Diastatic Power, ° ASBC)	> 180	0	> 200	0
	160–180	4	180–200	4
	120–160	7	140–180	7
	100–120	4	120–140	4
	< 100	0	< 120	0
Alpha-amylase (20° DU)	> 90	0	> 90	0
	80–90	4	80–90	4
	45–80	7	45–80	7
	35–45	4	35–40	4
	< 35	0	< 35	0
Beta-glucan (ppm)	< 40	0	< 40	0
	40–60	3	40–80	3
	60–115	7	80–140	7
	115–200	3	140–200	3
	> 200	0	> 200	0